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XIII.—*On some Echinothurids from Japan and the Indian Ocean.* By Dr. TH. MORTENSEN, Copenhagen.

[Plates II.-V.]

IN the autumn of 1902 Professor F. Jeffrey Bell sent me six specimens of Japanese Echinothurids, asking me to examine them. I found them to belong to three different genera and species, two specimens of each. One of them proved to be an interesting new species of *Araosoma*, the two others to be identical with the two species described by Yoshiwara, *Asthenosoma ijimai* and *A. longispinum*, two species as yet insufficiently known, so that I had to leave it undecided in my revision of the Echinothuridæ in the 'Ingolf' Echinoidea* to which genus they should be referred. The collection thus proved to be of considerable interest. Knowing, however, that Dr. de Meijere was about to treat some closely related forms in the 'Siboga' Echinoidea, I thought it better to postpone examining the little collection till de Meijere's work had appeared, and Professor Bell willingly agreed to my proposition. As that eminent work has now appeared, no further delay is needed.

Meantime I have likewise received for examination four specimens of Japanese Echinothurids from the Museum of

* The Danish 'Ingolf' Expedition, iv. 1, Echinoidea, i (1903).

Hamburg belonging to the new *Aræosoma*-species and to *Asthenosoma ijimai*, two specimens of each. All these specimens, those from Hamburg as well as those from the British Museum, were taken by the same collector, Mr. Owsten, in the Sagami Sea at a depth of 50 fathoms. Further, I found among a collection of Echinids sent me for examination by Professor S. F. Harmer, of Cambridge, some specimens of a hitherto unknown species of *Phormosoma*. Having learnt from Professor Döderlein that this species is not represented among the collections of the 'Valdivia' Expedition, I thought it desirable to describe it also on this occasion. The specimens were taken (1892) by the 'Investigator' in the Bay of Bengal at a depth of 678 fathoms. With the permission of Prof. A. Alcock, Prof. R. Koehler (who will work out the Echinids of the 'Investigator'), and Prof. S. F. Harmer, the species is described here under the name of *Phormosoma verticillatum*, sp. n., the name indicating the most prominent feature of the species, viz. the curious verticillated primary abactinal spines.

The new species of *Aræosoma*, which, according to the wish of Professor Bell, I name *A. Owsteni*, in honour of the collector, is especially interesting on account of its primitive "tetradactyle" pedicellariæ. As regards Mr. Yoshiwara's two species, one (*Asthenosoma ijimai*) proves really to belong to the genus *Asthenosoma* as limited by me in the 'Ingolf' Echinoidea, the other (*Asthenosoma longispinum*) to the genus *Calveria*, and it can even scarcely be doubted that it is identical with *Calveria gracilis* (Agass.).

1. *Aræosoma Owsteni*, sp. n.

(Pl. II. figs. 1, 2; Pl. V. figs. 4-9, 11, 18-20.)

The test is rather flexible, of the usual low form; the edge is rounded, the actinal side flat. (By filling it with spirit through the anal opening under a moderate pressure the test assumes its natural form; a specimen of 140 mm. diameter was thus found to be 65 mm. high.)

The apical area is rather small (24 mm. in the specimen of 140 mm. diameter), of the usual Echinothurid type, the genital and ocular plates being widely separated. The genital plates are rather elongate; the genital openings are large, covered by a distinct papilla; they are situated in the middle of the plate. The madreporic plate is distinctly larger than the other genital plates; the pores do not spread over the neighbouring plates. The genital and ocular plates, as well as the numerous small anal plates, are covered with spines. The inner anal plates not distinctly elongate.

The interambulacral areas are twice as broad as the ambulacral. On the actinal side there is a rather regular series of large tubercles along the outer edge of the area and another more irregular series along the median part of the plates. A large intermediate tubercle is found on the plates near the ambitus, and on all the plates except a few of the adoral ones there are some medium-sized tubercles, forming an indistinct horizontal row on each plate. Several small tubercles are placed between the larger ones; they may be arranged along the inner and outer edge of the plates, but mostly they are irregularly distributed. The scrobicular areas are rather deep, provided along the edge with a circle of small depressions, a feature not known to me in any other Echinothurid. The membranous interstices (the sutures) between the plates are rather large; they can be seen only when the epidermis has been removed; they are directed a little adorally at the inner and outer end (Pl. II. fig. 1). The extension of the lapping of the plates is visible only from the inside of the test, so that, not having opened any of the specimens, I cannot give any particulars. On the abactinal side the tubercles are few, smaller, and quite irregularly placed. The sutures between the plates rise obliquely from the median line of the area.

In the ambulacral areas there is, on the actinal side, a large tubercle on the inner half of the large component, but only on every second plate, or even more distant; these tubercles do not form a very regular longitudinal series. Some smaller tubercles are placed irregularly on the ambulacral plates, at the inner edge or in the outer part, between the pores. The edges of the plates irregular, the plates widening where the large tubercles are placed. On the abactinal side the tubercles are very few and small, irregularly placed. The pores are very conspicuous, forming three rather distinct longitudinal series. Towards the apical area they are more irregularly placed, forming sometimes arcs of four, and it can scarcely be doubted that some of these plates have really four pairs of pores—a fact of no small interest, indicating that also in the family Echinothuridæ multigeminate pores may occur (comp. *Pelanechinus*).

The plates of the actinostome do not present peculiar features.

The primary spines of the abactinal side are evidently rather variable in length; in one of the specimens from Hamburg they are more than 25 mm. long (I have seen none unbroken), in the specimen figured they are more slender and have evidently been shorter; they are smooth and

straight. The secondary spines are provided with a poison-gland at the point. The primary actinal spines are rather short and robust, curved and thorny, ending in a rather large white hoof; those on the actinostome are flattened at the point, without hoof, otherwise thorny as the primary actinal spines. The secondary spines of the actinal side are likewise thorny, but quite small; smooth ones are also found, those near the ambitus provided with a poison-gland at the point. Transverse sections show the primary actinal spines to be almost compact; the abactinal ones are hollow as usual.

The pedicellariæ are of three kinds, viz. "tetradactyle," tridentate, and triphyllous. The tetradactyle pedicellariæ (Pl. V. figs. 4-6), which occur only on the actinal side, are very interesting, being evidently of a rather primitive form. They are three-valved, as is also the case in *A. tessellatum* (de Meijere, 'Siboga' Echinoidea, p. 35); but whereas in the latter species the valves are of the same beautiful highly finished structure as in those of *A. fenestratum* and *coriaceum*, they are here quite irregular, mostly unsymmetrically developed; even the stalk-shaped lower part of the blade is irregularly constructed. At the base of the valves are three rather large glands placed between the valves; they open through a pore at their upper end. The head of these pedicellariæ is a little more than 1 mm. long, the whole length of the pedicellaria being c. 3 mm. They do not seem to occur in one of the specimens from the Hamburg Museum; on the other hand, the tridentate pedicellariæ are very numerous in that specimen.

The tridentate pedicellariæ (Pl. V. figs. 8, 9, 18-20) are of one kind only, all intermediate forms uniting the rather different-looking extreme forms; the large form of tridentate pedicellariæ found in other species of *Araosoma* is not represented in this species. They are rather variable in size, the largest reaching c. 2.5 mm. (head). In the smaller ones the valves join in their whole length; the edge is strongly sinuate and extremely finely serrate. There is a distinct longitudinal toothed keel in the blade, in continuation of the apophysis, and a meshwork fills out the bottom at the sides of it (Pl. V. figs. 18, 19). In quite small ones the edge is almost straight or with a few indistinct sinuations in the lower part, and the keel is short or wanting. In the larger ones (Pl. V. figs. 8, 20) the valves do not join in their whole length, but are separate for about the lower third part; the keel is indistinct. The neck is short, the stalk of the usual irregular structure.

The triphyllous pedicellariæ (Pl. V. fig. 7) are elongate,

narrow, generally with a series of holes in the median line of the cover-plate.

Sphæridiæ are found on both sides, wanting only on the two or three plates nearest to the apical area. They do not present peculiar features.

The spicules (Pl. V. fig. 11) of the actinal tube feet are rather large, irregular, thorny, fenestrated plates, arranged in four longitudinal series. The sucking-disk is well developed. The abactinal tube-feet are large and prominent, with neither sucking-disk nor spicules.

The test is of a faint flesh-colour ("incarnatus")*, in two of the specimens rather pale. The spines of the abactinal side are greenish, those of the actinal side whitish; they are not ringed.

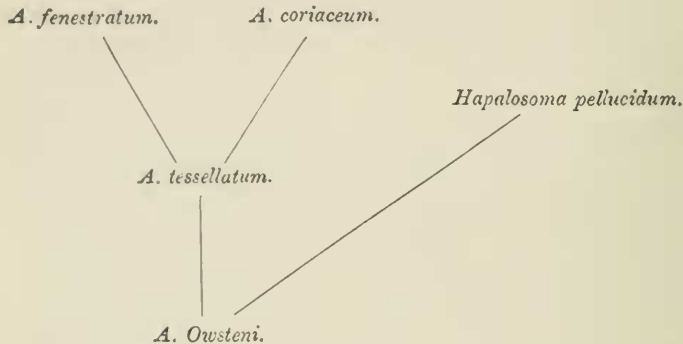
In my work on the 'Ingolf' Echinoidea I stated † that the tetradactylous pedicellariæ must probably be derived from the tridentate ones; de Meijere ('Siboga' Echinoidea, p. 35) thinks it more probable that they are derived from the oplicephalous form. It does not seem to me very probable that they be developed from either of these forms. There is, indeed, nothing in the structure of the tetradactylous pedicellariæ which points in either direction, and I do not see why they cannot represent a special form of pedicellariæ, developed independently of the other forms. By their glands (such are evidently also found in the most developed forms, those of *A. fenestratum* and *coriaceum*) they remind us of the globiferous pedicellariæ in other regular Echinids, and they must certainly be regarded as analogous, if not homologous, with the globiferous pedicellariæ. The form of pedicellaria in *Hapalosoma* described by me in the 'Ingolf' Echinoidea (p. 55) as a primitive globiferous pedicellaria, not seeing its relation to the tetradactylous pedicellariæ, cannot, of course, any longer be regarded as a primitive form, now that the three-valved "tetradactylous" pedicellariæ of *A. tessellatum* and *A. Ouwsteni* have been made known. As rightly pointed out by de Meijere, it must be regarded as a case of extreme development, in which the valves have become rudimentary and the glands excessively developed.

The form of these curious tetradactylous pedicellariæ shows such gradual changes that it seems reasonable to regard *A. Ouwsteni* as the most primitive of the species of *Aræosoma*; the fact that the largest form of tridentate pedicellariæ is

* Saccardo, 'Chromotaxia,' ii. ed. (1894).

† According to de Meijere. I am unable to find the place where the statement occurs, but I dare not deny that I really made it.

wanting in this species is in accordance therewith. A more advanced stage is shown by *A. tessellatum*, whereas the exquisite form of tetradactylous pedicellariæ found in *A. fenestratum* and *coriaceum* assigns to these species the highest place in this series of species. The "tetradactylous" pedicellariæ of *Hapalosoma* show this genus to be derived from a form with three-valved "tetradactylous" pedicellariæ, like *A. Owsteni*. The relations of these forms may be graphically shown thus:—



De Meijere ('Siboga' Echinoidea, p. 36) finds in two of his specimens of *A. tessellatum* the small form of tridentate pedicellariæ identical with those found by me ('Ingolf' Echinoidea, p. 52, pl. xiv. fig. 20) in the specimen from 'Challenger' St. 219 referred by Agassiz to *Calveria* ("*Asthensoma*") *gracilis*; in the other specimens they are like those of the type specimen ('Ingolf' Ech. pl. xiv. fig. 15): "Es fragt sich da ob dasselbe nicht mit dem erwähnten Exemplar der St. 219 identisch wäre"; he suggests that this specimen is only a badly preserved specimen of *A. tessellatum*. Through the kindness of Professor F. Jeffrey Bell the specimen in question was sent to Copenhagen, so that I have been able to examine it closely, and can give figures of it (Pl. IV. figs. 3, 4). It is a young specimen (30 mm. diameter), without genital openings, not very badly preserved, the structure of the test being even excellently seen; but of pedicellariæ no more can be found than what I have already made known in my 'Ingolf' work; the spines are all broken. The actinal side is like the inner part of the actinal side of the type specimen of *A. tessellatum*, as figured in 'Challenger' Ech. (pl. xix. a. fig. 1), with a primary tubercle at the outer end of each interambulacral

plate and only small tubercles on the rest of the plate. The ambulacral plates carry no large tubercles. The abactinal side differs rather strikingly from that of the type (Chall. Ech. pl. xix. b. fig. 2), there being a distinct primary tubercle on every second interambulacral plate, forming a conspicuous regular vertical series. The membranous interstices between the plates are distinct; the plates are not obliquely directed, as in the type, but quite regularly horizontal. The same holds good for the ambulacral plates, which have only a few larger tubercles. The pores are arranged as in the type specimen of *tessellatum*. The differences in the test, together with that in the pedicellariæ, would not seem to justify de Meijere's view that it is a young *A. tessellatum*. However, as I have no material of this species, I do not venture to pronounce a definite opinion, but shall be content with giving the above particulars of the specimen in question.

2. *Asthenosoma ijimai*, Yoshiwara.

(Pl. III. figs. 1, 2; Pl. V. figs. 1-3, 10, 12-14.)

Asthenosoma ijimai, Yoshiwara, 1897, "On Two new Species of *Asthenosoma* from the Sea of Sagami," *Annotations Zool. Japon. i.* p. 8, pl. ii. figs. 8-12.

The four specimens before me agree very well with the description given by Yoshiwara. Figures are here given of the species from photographs, the figures given by Yoshiwara being rather unsatisfactory. Otherwise I need not add anything to the description of the structure of the test, except of the madreporic plate. According to Yoshiwara it is "divided into four separate pieces of unequal size, the largest occupying the normal position," a feature which he thinks is merely an individual abnormality. It cannot properly be said that the madreporic plate is divided; it is the madreporic pores which have spread over the neighbouring plates, a feature known also in *A. varium* (Döderlein and de Loriol), and upon the whole not very seldom occurring among Echinids. It is seen in all the four specimens, and must thus certainly be regarded as a normal feature.

Of the pedicellariæ, Yoshiwara only says he has found two kinds, "one large and long-headed, the other small, long-stemmed, and trifid"; no figures are given. As in the other species of *Asthenosoma*, only tridentate and triphyllous pedicellariæ occur. Of the tridentate ones I find only two forms, corresponding to the larger and smaller form of the other species of this genus (comp. 'Ingolt' Echinoidea, p. 49). In the larger form (Pl. V. figs. 2, 12) (head up to 2.2 mm.)

the valves are apart, though not so widely as in *A. varium* and *Grubei* (in *A. urens* and *heteractis* * this form of pedicellaria is not known), joining only at the point. The edge of the outer part is a little sinuate, thus faintly indicating the large sinuations found here in the other species (comp. 'Ingolf' Ech. pl. xiv. fig. 7); in the pedicellariæ from the actinal side, however, the sinuations are more developed, but only the outer one on each side, two deep sinuations being never found as in the other species. These pedicellariæ thus afford a very distinct character for this species. The blade is filled with a coarse meshwork; the edge is irregularly serrate, also along the unusually thick basal part; the neck is short. Those found on the abactinal side are green-coloured.

The second form of tridentate pedicellariæ (Pl. V. figs. 1, 13, 14) is more richly developed than in the other species, perhaps on account of the absence of one form; they occur in very different sizes, the larger ones reaching the same size as the first form. The valves are long and narrow, joining in their whole length. The blade is provided with a toothed median keel, and otherwise, especially in the larger pedicellariæ, filled with a coarse meshwork. In quite small ones there is only little meshwork. The edge is finely serrate, straight in the small specimens, with some sinuations in the outer part in the larger ones. These pedicellariæ occur on both sides of the test, those on the abactinal side generally larger and green, like the other form of tridentate pedicellariæ. The neck is well developed.

The triphyllous pedicellariæ (Pl. V. fig. 3) have a long open slit in the cover-plate, as in the other species of the genus, but the form is somewhat different, the outer part being broader than in those species (comp. 'Ingolf' Ech. pl. xii. fig. 18).

The spicules (Pl. V. fig. 10) are somewhat more numerous and a little larger than in the other species, especially towards the sucking-disk. The sphaeridiæ continue on the abactinal side almost to the apical system.

The primary actinal spines are almost white, not banded as in the other species of this genus. The abactinal spines are coloured alike in both areas, and in none of them is the enclosing skin annularly constricted. The secondary spines of the actinal side are thorny in their outer half, not "mostly smooth," as stated by Yoshiwara.

"The most prominent feature by which this species can be

* In a specimen of *A. heteractis* just received from Singapore (dredged by Mr. Gad) I find the large form of tridentate pedicellaria to occur. It is quite like that of *A. varium*.

distinguished from all known members of the genus lies in the peculiar arrangement of the primary tubercles," says Yoshiwara. In *A. virium*, however, the arrangement of the primary tubercles is very similar (comp. fig. 2a, pl. 5), of Döderlein, "Echinoidea von Amboina und Thursday Island" *). The essential distinguishing characters of this very distinct species are found in the pedicellariæ and spicules, and the non-ringed primary actinal spines. The little developed, not annularly constricted bag of skin on the abactinal spines is an additional, though probably less reliable, character.

A. ijimai in its general appearance resembles the other species of the genus, with the conspicuous covering of the abactinal side by close-set, ringed, almost equally sized, skin-clad spines.

3. *Calveria gracilis* (Ag.).

Asthenosoma gracile, Agassiz, 1881, 'Challenger' Echinoidea, p. 89, pl. xvii. a. figs. 1-4.

Asthenosoma longispinum, Yoshiwara, 1897, *op. cit.* p. 5, pl. ii. figs. 1-7.
Calveria gracilis, Th. Mortensen, 1903, 'Ingolf' Echinoidea, p. 51, pl. xiii. fig. 3; de Meijere, 1904, 'Siboga' Echinoidea, p. 34, Taf. xiii. fig. 152.

The "*Asthenosoma longispinum*" of Yoshiwara so closely agrees with *Calveria gracilis* (Ag.) that I cannot find a single character by which to distinguish it from that species, with which, accordingly, it must be regarded as synonymous. It is only to be remarked that in the type specimen of Agassiz some violet patches are found on the actinal side, which is not the case in the specimens before me. The colour is dark red, almost claret-coloured ("vinosus") in the one specimen, rather pale, but of the same tint in the other.

This species is very closely related to *C. hystrix*; the only distinct difference I can find is the colour, which is always beautifully red ("ruber") in *C. hystrix*. The tubercles of the outer interambulacral plates of the actinal side are rather more numerous than in *hystrix*, as pointed out by Agassiz, a not very prominent feature. In the pedicellariæ no distinct differences are found. The chief peculiarity, indeed, lies in the geographical distribution of the two species. If both were found together they would certainly be regarded, at most, only as varieties of one species.

To the description given by Yoshiwara a few corrections must be made. The larger of the primary ambulacral plates are stated to "consist of three pieces apposed together in a

* Sen.ou's 'Forschungsreisen,' v. 1902; Jen. Denkschr. viii.

transverse row." This is not the case in the specimens before me, and, to judge from the figures given by Yoshiwara, it is doubtless simply due to the breaking of the plates in handling the specimens. A very startling statement is that the teeth are keeled. This would be very curious and unexpected, as all other *Echinothurids* have unkeeled teeth. The specimens before me, in fact, have unkeeled teeth, and the statement of Yoshiwara is evidently wrong.

I must corroborate the statement that genital papillæ occur in this species, and it may be added that such structures may also be found in *C. hystrix*, though generally little developed. The abactinal tube-feet are unequally developed, those in the inner row being larger than the outer ones.

4. *Phormosoma verticillatum*, sp. n.
(Pl. IV. figs. 1, 2; Pl. V. figs. 15-17.)

This species, as regards general appearance, is very similar to *Ph. placenta*. On the actinal side the large tubercles (and areoles) do not reach quite so close to the peristome as in that species; they are arranged in a broad band along the outer edge of the actinal side, the inner part around the peristome looking more naked, whereas in *Ph. placenta* the large tubercles cover the whole actinal side from the outer edge to the peristome. The marginal fringe of small spines is well developed. The abactinal side of the test is almost exactly as in *placenta*; in the interambulacra the tubercles are generally, but not always, arranged in an arc of three on each of the outer plates; on the uppermost plates the number of tubercles is reduced to two or one, the arc thus disappearing. This arrangement of the tubercles in a more or less distinct arc may also occur in *placenta*, though seldom.

The peristome is rather small, 19 mm. in a specimen of 63 mm. diameter; in a specimen of *placenta* of 66 mm. diameter the peristome is 23 mm. Although there is some variation in the size of the peristome in *placenta*, it is upon the whole undoubtedly somewhat larger in that species than in *verticillatum*. The same fact holds good for the apical system, and to a greater extent; in the specimen 63 mm. in diameter of *verticillatum* the apical system is only 13 mm. in diameter, whereas in the specimen of *placenta* 66 mm. in diameter it is 22 mm. There is a distinct genital papilla, which may, however, also be the case in *placenta*.

The pedicellariæ are quite like those of *Ph. placenta*; the tridentate pedicellariæ are of the short and broad form found in specimens from Davis Strait and the Gulf of Mexico

(‘Ingolf’ Ech. pl. xii. figs. 2, 3). The spicules are rather small, irregular, fenestrate plates, arranged in the lower part of the tube-foot in two distinct series; there is no sucking-disk and no prolongations from the spicules into the partition-wall of the foot (*Ph. bursarium*). The abactinal tube-feet are almost quite destitute of spicules.

The primary abactinal spines, both ambulacral and interambulacral, are very characteristic (Pl. V. figs. 15, 16). In the lower part they are quite smooth; some way out several spread thorns appear, and these soon become arranged in very distinct and rather distant whorls, the part between the whorls being quite smooth. All these spines unfortunately are broken, so that it is impossible to give any idea of their length or of the structure of the point. The spines are straight. These spines afford the most prominent character of the species. In *Ph. bursarium* the primary abactinal spines are curved and smooth, in *placenta* straight and smooth. The secondary spines (Pl. V. fig. 17) are thorny in their whole length, but the thorns are not arranged in whorls. The spines of the actinal side are like those of the other species.

The shape of the test is the same as in *placenta*, but it is more delicate and fragile than in that species. The specimens before me are bleached, only the skin-bag of the primary actinal spines is faintly violet.

This species is evidently nearly related to *Ph. placenta* and *bursarium*, whereas *Ph. alternans*, de Meijere, on account of the different arrangement of the tubercles and its pedicellariæ being provided with a keel, stands more apart. De Meijere (‘Siboga’ Ech. p. 32) says respecting this species:—“Es scheint mir eine kleine Erweiterung der bezüglichen Diagnose [of the genus *Phormosoma*] mehr erwünscht, als dass ich für diese Art gleich wieder eine neue Gattung errichten würde.” I quite agree with de Meijere that the species described by him ought to be referred to the genus *Phormosoma*, for the present at least. If, on the other hand, there should prove to be other species more nearly related to it than to the other group of species, it would probably be justifiable to create a new genus for them. The genus *Phormosoma*, indeed, seems to me so different from the other Echinothurids that I should not be surprised if it eventually proved to form a separate subfamily of the Echinothurids.

De Meijere (‘Siboga’ Ech. p. 250) finds it a drawback to the new classification given by me in the ‘Ingolf’ Echinoidea that new species do not always suit the diagnoses of the genera given there, as, e. g., *Phormosoma alternans*. May not

that be a somewhat unjust reproach? The diagnoses of genera must, of course, be made from a comparative study of the species known, and then it has to be left to the authors describing new species to emend the diagnoses if the new species prove the old diagnoses to be too narrow or too wide. Such has always been and will remain the case, as it cannot be demanded that one should guess beforehand the characters of species as yet unknown. It may well be said to be a drawback to our classifications, but it is common to all of them, and not peculiar to my classification of Echinids. When, further, de Meijere says (*loc. cit.*), "Das System führt also zu grosser Zersplitterung, was wohl den Vorzug hat, dass nur das sehr ähnliche zusammen bleibt, aber auch den Nachtheil, dass die doch nahe Verwandtschaft mit der abgetrennten Form aus dem Genus-Namen nicht mehr zu erkennen ist," I might remark that it is allowed and desirable to make the new generic names such that they indicate to which old genus the new one is allied—for instance, let the names of Cidarids end in *-cidaris*, those of Diadematids in *-diadema*, &c. The principal object, however, is to get the genera, and above all the species, distinct and clear. The species are the units with which we must work, and when these units are composed of different things—as was the case with several of the Echinid species—much labour will be lost (*e. g.*, on the geographical distribution). The arrangement of the species in genera and the genera in families &c. is of secondary importance, and differences of opinion on this subject are of far less wide-reaching consequences. I may cite, in conclusion, the words of L. Agassiz*:—"Loin d'être nuisible aux vrais progrès de la science, cette multiplication des genres, lorsqu'ils sont établis sur des caractères précis, ne saurait avoir d'autre effet que de rapprocher de plus au plus les espèces que leurs caractères naturels lient le plus étroitement. C'est-là le grand avantage des petits genres, et cet avantage est surtout sensible dans les familles, dont toutes les espèces se ressemblent par leur aspect extérieur et par l'ensemble de leurs caractères."

EXPLANATION OF THE PLATES.

[The microscope used was a Zeiss instrument.]

PLATE II.

Fig. 1. *Aræosoma Owsteni*, from the actinal side.

Fig. 2. Same, from the abactinal side.

* Introduction to Valentin's 'Anatomie du genre *Echinus*,' p. x.

PLATE III.

- Fig. 1. *Asthenosoma ijimai*, from the actinal side.
 Fig. 2. Same, from the abactinal side.

PLATE IV.

- Fig. 1. *Phormosoma verticillatum*, actinal side. Nat. size.
 Fig. 2. Same, abactinal side. Nat. size.
 Fig. 3. Young *Aræosoma tessellatum* (?). (The *Asthenosoma gracile* of Agassiz from 'Challenger' St. 219.)
 Fig. 4. Same from the abactinal side. Actinal side. Nat. size.

PLATE V.

- Fig. 1. Tridentate pedicellaria, small form, of *Asthenosoma ijimai*. (Obj. a*, Oc. 3.)
 Fig. 2. Valve of tridentate pedicellaria, large form, of *Asth. ijimai*. (Apochr. Obj. 160, Comp. Oc. 2.)
 Fig. 3. Valve of triphyllous pedicellaria of *Asth. ijimai*. (Obj. AA, Oc. 3.)
 Fig. 4. Valve of "tetradactylous" pedicellaria of *Aræosoma Owsteni*, front view. (Obj. AA, Oc. 2.)
 Fig. 5. "Tetradactylous" pedicellaria of *Aræosoma Owsteni*. (Obj. a*, Oc. 3.)
 Fig. 6. Valve of "tetradactylous" pedicellaria of *Aræos. Owsteni*, side view. (Obj. AA, Oc. 2.)
 Fig. 7. Valve of triphyllous pedicellaria of *Aræos. Owsteni*. (Apochr. Obj. 80, Comp. Oc. 4.)
 Fig. 8. Valve of tridentate pedicellaria of *Aræos. Owsteni*. (Apochr. Obj. 160, Comp. Oc. 2.)
 Fig. 9. Tridentate pedicellaria of *Aræos. Owsteni*. (Apochr. Obj. 80, Comp. Oc. 2.)
 Fig. 10. Spicules of *Asthenosoma ijimai*. (Obj. D, Oc. 1.)
 Fig. 11. Spicules of *Aræosoma Owsteni*. (Obj. D, Oc. 1.)
 Fig. 12. Tridentate pedicellaria, large form, of *Asth. ijimai*. (Obj. a*, Oc. 3.)
 Fig. 13. Valve of tridentate pedicellaria, small form, of *Asth. ijimai*. (Obj. AA, Oc. 1.)
 Fig. 14. Ditto. (Ditto.)
 Fig. 15. Part of primary abactinal spine of *Phormosoma verticillatum*. (Obj. AA, Oc. 1.)
 Fig. 16. Primary actinal spine, lower part, of *Phormosoma verticillatum*. (Obj. a*, Oc. 2.)
 Fig. 17. The point of a secondary abactinal spine of *Phormosoma verticillatum*. (Obj. AA, Oc. 3.)
 Fig. 18. Valve of tridentate pedicellaria of *Aræos. Owsteni*. (Obj. AA, Oc. 1.)
 Fig. 19. Ditto. (Ditto.)
 Fig. 20. Tridentate pedicellaria of *Aræos. Owsteni*. (Obj. a*, Oc. 3.)